A High-Resolution Photon Correlation Spectrometer to Study Near-Critical Static and Dynamic Light Scattering

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A high-resolution experimental setup for static and dynamic light scattering in near critical as well as in colloidal liquid systems has been developed. The setup enables one to study fluctuations and heterogeneities in various liquid systems (polymer solutions, near-critical liquid solutions, liquid crystals, etc.), which exhibit strong light scattering. Such physical properties like the osmotic susceptibility, diffusion coefficient, correlation length, and particle size can be measured. A design of the setup is based on the optical scheme with two fixed scattering angles: 30° and 150°. The scattered light is received by a photomultiplier operating in a single photon counting mode. Two identical He-Ne lasers and a photomultiplier receiving system have been aligned at the fixed angles. Small parts of the incident-beam intensity of both lasers are directed by means of beam splitters and optical guides to the photomultiplier, serving as calibration intensities. Two three-position optical shutters set the operation procedure. Our measurement procedure allows eliminating the influence of the laser power drift, as well as slow fluctuations in the sensitivity of the photomultiplier receiving system, on the results of the measurements. A square optical cell with a selected optical path of 0.5, 1, 2, or 4 mm is placed in a precise three-stage thermostat. For the temperature measurements and control, a precise PID controller has been used. This system allows stabilizing the temperature within 0.3 mK during a few days. An original ("PhotoCor") single-board correlator has been used for measurements of both light scattering intensity and time-dependent autocorrelation function of the scattered light. An overall accuracy of the intensity and diffusion coefficient measurements at 0.01 K to the critical temperature is estimated to be about 1%. The instrument is fully automated. Our original hardware and software are designed to assign, control, and analyze all relevant input and output parameters during the measurement procedure.